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PROFESSIONAL PAPER.

THE VERBENA BUD MOTH.

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(In cooperation with the Virginia Truck Experiment Station, Norfolk, Va.)

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INTRODUCTION AND HISTORY.

During the fall of 1913 a bed of ornamental snapdragon (Antirrhinum) at the Virginia truck experiment station, Norfolk, Va., was found to be infested by the larvæ of a bud moth. The adults were reared and identified as *Olethreutes hebesana* Walk., or the verbena bud moth. Although long ago recognized as injurious to certain ornamentals, it appears that no attempt had been made to determine its life history, with the exception of a short note regarding the habits of the larva and a description of the different stages. Since 1868, at which date it was fully described, an interval of over 46 years has elapsed and but little has been published concerning it.

The first intimation we have of this insect as a pest occurs in a letter by A. S. Fuller, forwarded in 1868 with specimens to C. V. Riley, then State entomologist of Missouri. Riley reared the adults from the seeds of Tigridia and later identified the moth as an undescribed species belonging to the tortricid genus Penthina. In honor of the discoverer Riley named the species *fullerea*. At about the same time two other workers independently discovered the same insect doing injury to flowering plants. Mrs. Mary Treat found it exceedingly

[1] This term is used in its broadest sense and includes all vegetables, and in addition ornamental plants.—F. H. C.

Note.—This bulletin gives the life history of the verbena bud moth, its food plants, and methods for its control.

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injurious to verbena and sent specimens to Riley for identification, while Miss M. E. Murtfeldt found the insect injuring Antirrhinum at Kirkwood, Mo.

The species was later observed and collected by entomologists in various sections of the country, and notices to that effect appear scattered through our literature.

NAME AND SYNONYMY.

Popularly this moth has only one name, the "verbena bud moth," given it by Mrs. Mary Treat in 1869 from the plant upon which it was found feeding. Scientifically, however, it has in its brief history been known by several names and has been shifted from one genus to another. Both Fernald and Walsingham have listed the species under the genus Penthina. Later it has been listed by H. G. Dyar and J. B. Smith under the genus Olethreutes. As it now stands we have the following synonymy:

Olethreutes hebesana Walk., Dyar, 1902.
Sciaphila hebesana Walk., 1863.
Carpocapsa inexpertana Walk., 1863.
Sericoris fœdana Clem., 1865.
Penthina fullerea Riley, 1868.
Penthina hebesana Wlsm., 1879.

DISTRIBUTION.

Apparently the verbena bud moth is distributed locally at least through the eastern part of the United States. It is evidently a native American species and has been collected and found injurious in Maine, Massachusetts, New York, New Jersey, Pennsylvania, Virginia, Texas, Kansas, Indiana, and California, and is also reported from Canada.

FOOD PLANTS.

So far as known this species has confined its injuries solely to flowering plants. It has been reared from and found injurious on the following food plants: Tiger flower (*Tigridia pavonia*), snapdragon (*Antirrhinum* spp.), flag (*Iris* spp.), hedge nettle (*Stachys palustris*), mullein (*Verbascum thapsus*), verbena (*Verbena* spp.), closed gentian (*Gentiana andrewsii*), false foxglove (*Dasystoma flava*).

According to the records in the Bureau of Entomology it has several times been reared from the stems of *Tigridia pavonia* and was injurious to verbenas on the Department of Agriculture grounds in Washington, where it fed upon the flower heads, webbing a number of seed capsules together to feed upon the young and undeveloped seeds. The heads of verbena are probably not its natural habitat, since it is necessary to web them together. Among other food plants in the records of the Bureau of Entomology are the closed gentian (*Gentiana andrewsii*) and false foxglove (*Dasystoma flava*). It has been found to feed in the dry seed pods of both these species, which may be included among its wild food plants.

THE MOTH.

Mr. C. H. Popenoe found the pods of mullein literally peppered by the work of this insect in Kansas and Indiana and suggests that mullein was probably the original food plant.

DESCRIPTION.

The adult of *Olethreutes hebesana* is a small dark-brown moth (Pl. I, *b*) of the usual tortricid type, with a wing expanse of about one-half inch. A technical description, including the markings, from specimens before the writer, follows:

Alar expanse, 0.50 inch; length, 0.23 inch. Head with buff-brown tufts; eyes and palpi at apices somewhat darker, antennæ short (one-third length of forewing), filiform and simple in both sexes. Thorax with the shoulder pieces and dorsal tuft uniform buff-brown. Abdomen more gray. Forewings silvery gray, with metallic blue reflections more or less intense; the lighter parts carneous, with a silvery luster; and the whole intricately shaded with dark vandyke brown. The light is mostly reflected from the beautifully marked edges of the scales, which are transversely imbricated. There are three principal dark-brown marks, namely, one broad and irregular, crossing the wing a little beyond the middle and containing a more or less complete pale ring on the posterior border just within the anterior median cell; another, subobsolete, opposite, on its inner border. Between this transverse band and the base is a smaller, irregular, brown mark, not extending to the inner margin, and between the pale ring above described and the apex of the wing a third conspicuous brown mark, not extending more than one-third the width of the wing. Each of these dark marks is relieved by a pale border, and between them the brown, blue, and flesh color are intricately mixed. Apex of wing rounded; posterior border dark, with a series of eight or nine more or less distinct rust-brown angular spots, just inside, the two largest being costal; fringes dark brown, with a deep-blue gloss. Hind wings light brown, this color becoming deeper around the posterior margin; fringes lighter. Whole undersurface of a uniform leaden brown, that of forewings somewhat darkest and showing costal marks. No sexual difference is noted except in the narrower and less pointed male abdomen.

Following are the original descriptions of the larva and pupa, from the writings of Dr. C. V. Riley:

THE LARVA.

Penthina Fullerea.—Average length exactly half an inch; general color of a uniform dirty carneous, frequently inclining to yellow and to green; two wrinkles on each segment; head jet-black, without a spot or shade; cervical shield also black, and occupying the whole surface of segment one; piliferous spots in the normal position, but scarcely observable, even with a lens, other than by the hairs proceeding from them; feet, legs, and venter of the same color as upper surface. (Fig. 1.)

THE PUPA.

The chrysalis (Pl. I, *e*).—Average length, 0.25 inch; of the usual form, with a distinct row of teeth above, on the anterior portion of each segment, and a few minute bristles at the extremity and along the sides. It is formed within a silken cocoon, constructed in one of the three tubes of the seed, and forces itself halfway out at one side when the moth is about to emerge. (Pl. II, *b;* Pl. III.)

THE EGG.

The egg and newly hatched larva have not heretofore been described. The author's description of the egg follows:

The egg.—The egg is oval with the outline somewhat irregular; long diameter, 0.45 mm., shorter diameter, 0.30. It appears flat below, with the upper surface hemispherical, pitted and also granulated. In color it is usually whitish or light cream and readily distinguishable, particularly when deposited on green sepals. Later the eggs invariably turn slightly reddish, some before hatching taking on a grayish hue.

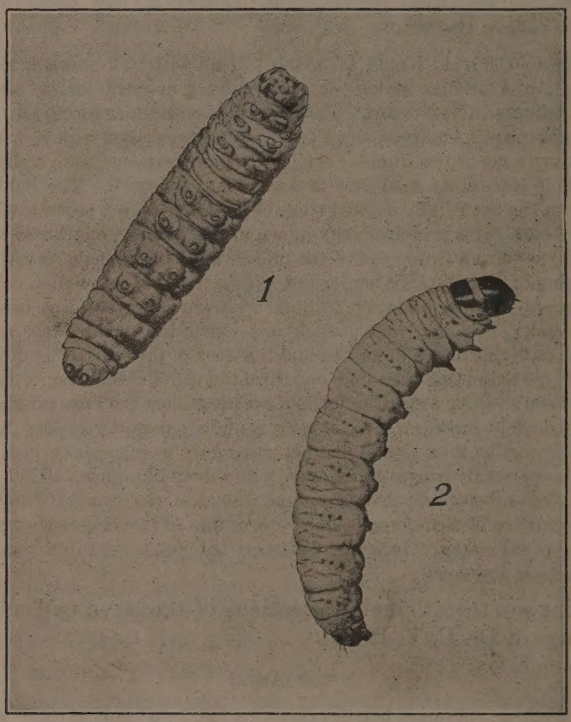
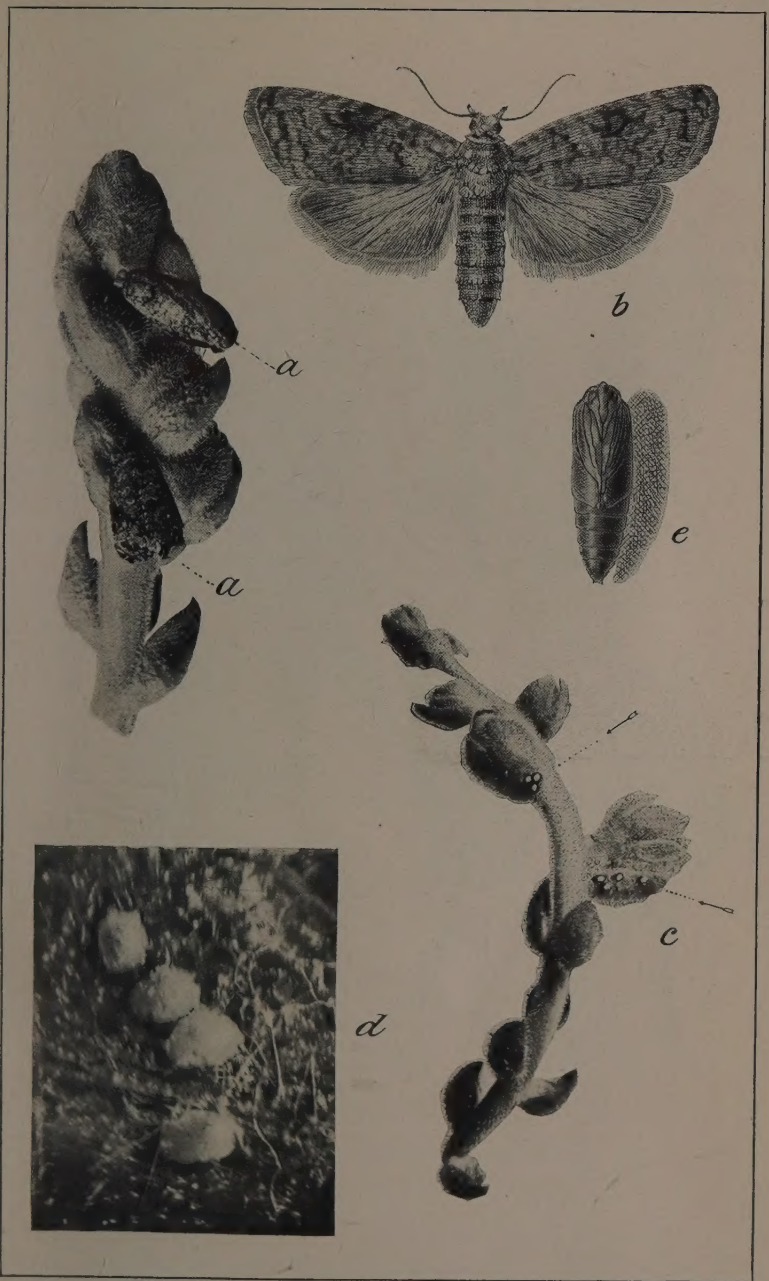


FIG. 1.—The verbena bud moth: *1*, Larva, ventral view; *2*, larva, lateral view, greatly enlarged. (Original.)

The eggs are deposited singly or sometimes in groups of from three to five on sepals of flower buds, or along the upper part of the tender flower stalk, and hatch in from 7 to 10 days. (Pl. I, *c*, *d*.)

HABITS AND SEASONAL HISTORY.

In the vicinity of Norfolk, Va., and on the grounds of the Virginia Truck Experiment Station the adults of the verbena bud moth, in 1913, began to issue on or about the last week in March. These were



a, MOTHS OVIPOSITING ON ANTIRRHINUM; *b*, FEMALE MOTH, ENLARGED; *c*, EGGS ON BUDS, ABOUT NATURAL SIZE; *d*, EGGS, ENLARGED; *e*, PUPA, ENLARGED. (ORIGINAL.)

THE VERBENA BUD MOTH (OLETHREUTES HEBESANA).

a, FLOWER-STALK SHOWING DROOPING CAUSED BY ATTACK OF LARVÆ, NATURAL SIZE; *b*, SEED CAPSULES SHOWING PUPAL CASES, AND METHOD OF EMERGENCE OF MOTH, ENLARGED. (ORIGINAL.)

WORK OF THE VERBENA BUD MOTH ON ANTIRRHINUM.

SEED CAPSULES OF ANTIRRHINUM WHICH HAVE BEEN ATTACKED BY LARVÆ OF VERBENA BUD MOTH. EMPTY PUPAL CASES EXTRUDED. (ORIGINAL.)

WORK OF THE VERBENA BUD MOTH.

the progeny of overwintering pupæ. On March 30 moths were observed flying about a bed of snapdragon that had been severely infested the previous summer. At this date the flower buds of snapdragons were nearly ready to open.

The moths dart swiftly from plant to plant, but during bright days remain concealed among the plants. Being of a dark color and very small they are inconspicuous and not readily seen without close inspection. (Pl. I, *a*.) In the late afternoon or when the plants are disturbed the moths become active.

Oviposition occurs several days after emergence. On April 2 and 3 egg laying was observed on the flower buds. The moths invariably seek tender flower shoots upon which to oviposit, but according to observation prefer the sepals of flower buds, particularly those situated high up on the plant.

The larvæ as they emerge from the eggshells feed on the tender sepals and petals or on the flower stalk. At this time it is difficult to locate them. After feeding for a while they become more active and then direct their attacks indiscriminately. Some larvæ feed on the sepals and then bore through them, entering the flower and attacking the ovary. Others feed on the petals, stamens, and pistils of the flowers, finally reaching the ovaries. The flower stalk may be attacked by the larvæ, which first mine beneath the epidermis and feed on the juices. Later they may bore into the center of the stalk. (Pl. II, *a*.) They thus give the impression of being able to adapt themselves to many modes of feeding. The seed capsules formed by flowers which have escaped the ravages of the newly hatched larvæ are later vigorously attacked by those half grown. (Pl. III.) The larvæ that bore into the seed capsules continue to feed on the seed within, going from one seed capsule to another, until they have attained their growth. The capsules thus attacked are easily recognized by the small orifices at the base or side and by the excremental castings on the surface. In many instances two such capsules are webbed together by larvæ migrating from one capsule to another. The larvæ are easily alarmed and when disturbed have the interesting habit of thrusting out their heads, and sometimes in their alarm they wriggle out completely, dropping to the ground.

Under laboratory conditions the life cycle occupies 43 days, as follows:

Egg deposited March 2, 1913	Egg state, 8 days.
Larvæ hatched March 10, 1913	Larval state, 21 days.
Pupated March 31, 1913	Pupal state, 14 days.
Adult April 14, 1913	Life cycle, 43 days.

Less time is required during warm weather, as the following will show:

Eggs deposited July 7, 1913	Egg state, 7 days.
Larvæ hatched July 14, 1913	Larval state, 15 days.
Pupated July 31, 1913	Pupal state, 12 days.
Adult August 12, 1913	Life cycle, 34 days.

In the vicinity of Norfolk, Va., at least five or six generations are produced each year. This with the voracious and indiscriminate habit of feeding renders the species a very obnoxious pest when once it has obtained a foothold in a locality. This is particularly true where the production of seed is an object, since plants infested by this insect become worthless.

Besides undergoing all transformation within the seed capsule, the larvæ hibernate within this protection. During the winter larvæ in every stage of development, as well as pupæ, were found concealed in the seed capsules.

METHODS OF CONTROL.

Two methods of control were found effective against the larvæ of the verbena bud moth: (1) Poison spraying against the young larvæ, and (2) cutting back and destroying infested stalks.

SPRAYING.

Two poisons were employed in the spraying experiments.

(*a*) Arsenate of lead, 2 pounds to 50 gallons of water.
Fish-oil soap, 2 pounds to 50 gallons of water.
(*b*) Arsenite of zinc, 1½ pounds to 50 gallons of water.
Fish-oil soap, 2 pounds to 50 gallons of water.

The spraying was done as soon as the larvæ began to hatch and was directed toward the flower buds and young flower stalks. Subsequent investigation developed that from 85 to 90 per cent of the larvæ had been killed. A second spraying followed eight days later, owing to the fact that after the first spraying some moths were observed ovipositing.

CUTTING BACK AND DESTROYING INFESTED FLOWER STALKS.

The nature of the verbena plant is such that during the fall of the year the entire growth may be cut back and new growth will start the following year. In this way the whole brood, including all stages of the pest, is entirely eradicated. If this method is not followed in the fall, one may, in the spring of the year, cut out carefully the infested stalks, and the flower bed should be gone over several times in order to obtain those missed at the time of the first cutting.

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